DECLARATION

I, Yoshiharu Kobata of c/o SHIGA INTERNATIONAL PATENT OFFICE, 2-3-1 Yaesu, Chuo-ku, Tokyo 104-8453 JAPAN, understand both English and Japanese, am the translator of the English document attached, and do hereby declare and state that the attached English document contains an accurate translation of the official certified copy of Japanese Patent Application No.2002-287453 and that all statements made herein are true to the best of my knowledge.

Declared in Tokyo, Japan

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(Title of the Invention) FILM PATTERN FORMING METHOD, FILM PATTERN FORMING DEVICE, CONDUCTIVE FILM WIRING, ELECTRO-OPTIC DEVICE, ELECTRONIC APPARATUS, AND NON-CONTACT TYPE CARD MEDIUM

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[Title of the Invention] FILM PATTERN FORMING METHOD, FILM PATTERN FORMING DEVICE, CONDUCTIVE FILM WIRING, ELECTRO-OPTIC DEVICE, ELECTRONIC APPARATUS, AND NON-CONTACT TYPE CARD MEDIUM

[Claims]

[Claim 1]

A film pattern forming method for forming a film pattern by ejecting a liquid drop of a liquid including conductive fine particles onto a prescribed film forming area on a substrate, comprising

a surface treatment process step for performing a surface treatment on the substrate before ejecting the liquid drop, wherein

a contact angle of the liquid drop with respect to the substrate is set in the surface treatment process step.

[Claim 2]

A film pattern forming method according to claim 1, wherein the contact angle is set according to a diameter of the liquid drop after ejection onto the substrate.

[Claim 3]

A film pattern forming method according to claim 1 or claim 2, wherein the contact angle is in a range of 15° to 45°.

[Claim 4]

A film pattern forming method according to claim 1, further comprising

a conversion process step for converting the liquid having been ejected onto the substrate into a conductive film by a heat treatment or an optical treatment.

[Claim 5]

A film pattern forming device for forming a film pattern by ejecting a liquid including conductive fine particles onto a prescribed film forming area on a substrate,

wherein

a film pattern is formed by means of a film pattern forming method according to any one of claim 1 to claim 4.

[Claim 6]

Conductive film wiring formed by means of a film pattern forming method according to any one of claim 1 to claim 4.

[Claim 7]

An electro-optic device containing conductive film wiring according to claim 6.

[Claim 8]

An electronic apparatus containing an electro-optic device according to claim 7.

[Claim 9]

A non-contact type card medium having an antenna circuit formed by conductive thin film wiring according to claim 8.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention]

The present invention relates to a film pattern forming method, a film pattern forming device, conductive film wiring, an electro-optic device, an electronic apparatus, and a non-contact type card medium.

[0002]

[Prior Art]

As a manufacturing method of wiring which is used for an electronic circuit, an integrated circuit and the like, for example, a lithography method is used. In the lithography method, major facilities such as a vacuum device and the like and complicated process steps are required. In addition, only a few percent of the raw

materials are actually used, and most of the raw materials are discarded. As a result, the manufacturing cost is high. Consequently, as a processing method alternative to the lithography method, there is proposed a method in which a liquid which contains a functional material is directly patterned on a base material by an ink jet method. For example, a liquid in which conductive fine particles are dispersed is directly patterned on a substrate by an ink jet method, and then, the pattern is converted into a conductive film pattern by a heat treatment process or laser irradiation (for example, refer to Patent document 1).

[0003]

Patent document 1 : U. S. Patent No. 5132248

[0004]

[Problems to be Solved by the Invention]

However, in the above conventional technique, there were problems as described below. That is, in the patterning operation by the ink jet method, it was not possible to control a shape, a dimension, a position and the like of the liquid drop (liquid) on an substrate unless an appropriate treatment was performed on the surface of the substrate; thus, it was difficult to manufacture a conductive film pattern having a desired shape. In the above described patent document, details of a method for controlling the ejected pattern shape are not disclosed.

[0005]

The present invention was made in consideration of the above problems. Objects of the present invention are to provide a film pattern method and a film pattern forming device, in which defects such as line breakage, short circuits or the like in a film pattern that are formed by the ink jet method are relimited.

Also, another object of the present invention is to provide conductive film wiring, in which it is difficult for a defect such as a line breakage, a short circuit or the like to occur. Furthermore, other objects of the present invention are to provide an electro-optic device, an electronic apparatus, and a non-contact type card medium, in which it is difficult for a defect such as a line breakage, a short circuit or the like in a wiring section to occur.

[0006]

[Means for Solving the Problem]

In order to solve the above problems, a film pattern forming method according to the present invention is a film pattern forming method for forming a film pattern by ejecting a liquid drop of a liquid including conductive fine particles onto a prescribed film forming area on a substrate. The film pattern forming method comprises a surface treatment process step for performing a surface treatment on the substrate before ejecting the liquid drop, wherein a contact angle of the liquid drop with respect to the substrate is set in the surface treatment process step.

Here, the film forming area denotes an area in which a film pattern is to be formed. The film forming area is formed mainly by a single line or curve, or by a plurality of lines or curves. Also, "defect" particularly refers to a problem such as a line breakage or the like which is generated in a formed film pattern.

According to the method described above, a contact angle is set in the surface treatment process step so that a defect does not occur in a formed film pattern, particularly in metal wiring (conductive film wiring) which is formed by conductive fine particles. Accordingly, it is possible to form metal wiring, which can be formed minutely and in which it is difficult for a defect such as a line breakage, a short circuit or the like to occur.

Here, the contact angle is determined by the interrelationship between the substrate and the liquid; therefore, the contact angle also depends on characteristics of the liquid. However, there are limitations such as surface tension, viscosity and the like to the characteristics of the liquid, which is ejected by the ink jet method. Therefore, in reality, it is difficult to adjust the contact angle by adjusting only the characteristics of the liquid. Thus, it is suitable to set the contact angle by performing a surface treatment on the substrate.

[0007]

In a film pattern forming method according to the present invention, the contact angle is set according to a diameter of the liquid drop after ejection onto the substrate.

According to this method, the contact angle is suitably selected according to the diameter of the liquid drop; thus, it is possible to form a superior desired film pattern.

[0008]

Furthermore, in a film pattern forming method according to the present

invention, the contact angle is in a range of 15° to 45°.

By applying this method, it is possible to form a superior desired film pattern without a defect in a formed film pattern.

[0009]

In a film pattern forming method according to the present invention, it is preferable to have a process step for converting the liquid, which has been ejected on the substrate, to a conductive film by a heat treatment or an radiation treatment. Because of this, it is possible to form conductive wiring by activating the conductivity of conductive fine particles. The heat treatment or the radiation treatment may be performed each time after ejecting the liquid drops or may be performed once after all ejection process steps are completed.

[0010]

A film pattern forming device according to the present invention is a film pattern forming device for forming a film pattern by ejecting a liquid containing conductive fine particles onto a prescribed film forming area on a substrate using any one of the film pattern forming methods described above.

The film pattern forming device described above satisfies requirements of limiting occurrences of defects on a formed film pattern by using a simple process step and, in addition, limits occurrences of problems such as short circuits and the like when a conductive film is formed.

[0011]

Conductive film wiring of the present invention is formed by any one of the film pattern forming methods described above.

Accordingly, by applying the present invention, it is possible to form conductive film wiring, which can be formed minutely and in which it is difficult for a defect such as a line breakage, a short circuit or the like to occur.

[0012]

An electro-optic device according to the present invention contains the conductive film wiring described above. As an electro-optic device of the present invention, it is possible to mention, for example, a liquid crystal display device, an organic electro-luminescence display device, a plasma display device or the like.

Also, an electronic apparatus according to the present invention contains an

electro-optic device according to the present invention.

Also, a non-contact type card medium according to the present invention contains an antenna circuit formed by conductive film wiring according to the present invention.

Accordingly, by applying the present invention, it is possible to provide an electro-optic device, and an electronic apparatus as well as a non-contact type card medium having this electro-optic device, in which it is difficult for a defect such as a wiring breakage, a short circuit, or the like in a wiring section or an antenna, to occur, and as a result, there are few defects.

[0013]

[Embodiments of the Invention]

Hereinafter, embodiments of the present invention will be explained.

First Embodiment

As a first embodiment, a wiring forming method, which is an example for forming a film pattern according to the present invention, will be explained. The wiring forming method according to the present embodiment comprises a surface treatment process step, an ejection process step, and a heat treatment / optical treatment process step.

Hereinafter, each process step will be explained.

[0014]

(Surface Treatment Process Step)

Various materials such as a Si wafer, a silica glass, a glass, a plastic film, a metal plate, and the like can be used as a substrate on which conductive film wiring is to be formed. In addition, a substrate, which is obtained by forming a base layer of a semiconductor layer, a metal layer, a dielectric layer, an organic layer, or the like on a surface of the substrate made of one of the various materials described above, can also be used as a substrate on which conductive film wiring is to be formed.

[0015]

On the surface of the substrate on which this conductive film wiring is to be formed, it is preferable to control a liquid repelling property (wettability) of a liquid that contains conductive fine particles. Specifically, it is preferable to set a contact angle of the liquid with respect to the surface of the substrate to be in a range of 15° to 45°.

Furthermore, in order to determine a setting value for the contact angle in the above range, first, a type of the substrate, on which conductive film wiring is to be formed, and a type of a liquid drop to be employed are determined. Next, based on this condition, a relationship between a contact angle and a diameter of a liquid drop after ejection onto the substrate is derived in advance. Then, a desired contact angle is determined according to the diameter of the liquid drop.

Hereinafter, a surface treatment method for obtaining a desired contact angle will be explained.

[0016]

In the present embodiment, a liquid repelling treatment is performed on a surface of the substrate in order to attain a prescribed value of a contact angle of the liquid which contains conductive fine particles. Furthermore, a surface treatment such as a lyophilic treatment is performed after the liquid repelling treatment.

First, a method for performing the liquid repelling treatment on a surface of the substrate will be explained.

As a method for the liquid repelling treatment, a method to form a self organizing film comprising an organic molecular film and the like on the substrate surface can be used. An organic molecular film for treating a surface of the substrate has, on one end side, a functional group capable of bonding with the substrate and, on the other end side, a functional group, which changes surface characteristics such as a liquid repelling property and the like of the substrate (controls a surface energy). At the same time, the organic molecular film has a normal chain of carbon or a partially branched chain of carbon, which connects the above described functional groups, and forms a molecular film such as a unimolecular film, for example, by self organizing and bonding with the substrate.

[0017]

The self organizing film comprises connective functional groups capable of reacting with atomic elements of a base layer such as a substrate or the like, and a remainder of normal chain molecules. The self organizing film is also a film formed by orienting chemical compounds with an extremely high orientation capability due to mutual reactions of these normal chain molecules. Since this self organizing film is formed by performing a unimolecular orientation, the film thickness can be made

extremely thin and the film becomes uniform at the molecular level. That is, since the same molecules are positioned on the surface of the film, a uniform and superior liquid repelling property and the like can be given to the film surface.

[0018]

As a chemical compound with a high orientation capability described above, for example, when fluoroalkylsilane is used, each chemical compound is orientated so that a fluoroalkyl group is disposed on a surface of the film to form a self organizing film. Therefore, a uniform liquid repelling property is given to the surface of the film.

[0019]

As a chemical compound which forms a self organizing film, for example, fluoroalkylsilane (hereinafter referred to as "FAS") such as heptadecafluoro-1,1,2,2tetrahydrodecyltriethoxysinane, heptadecafluoro-1, 1, 2,2 tetrahyrodecyl trimethoxysilane, heptadecafluoro-1,1,2,2tetrahydrodecyltrichlorosilane, tridecafluoro-1,1,2,2tetrahydrooctyltriethoxysilane, tridecafluoro-1,1,2,2tetrahdrooctyltrichlorosilane, trifluoropropyltrimethoxysilane and the like can be mentioned. Although it is preferable to use a single chemical compound by itself, it is acceptable to use two or more chemical compounds instead of using a single chemical compound, as long as the aim of the present invention is not lost. Also, according to the present invention, it is preferable to use the above described FAS as a chemical compound for forming the above described self organizing film so as to realize an adhesiveness to the substrate and a superior liquid repelling property.

[0020]

A structural formula for the FAS is expressed by $R_nSiX_{(4-n)}$. Here, n denotes an integer which is one or more and not greater than 3. X denotes a hydrolytic group such as a methoxy group, an ethoxy group, a halogen atom group, or the like. Also, R denotes a fluoroalkyl group and has a structure such as $(CF_3)(CF_2)x(CH_2)y$ (here, x denotes an integer which is in a range of 0 to 10 and y denotes an integer in a range of 0 to 4). When a plurality of Rs and Xs are connected to Si, each of all Rs and Xs may be the same. Alternatively, R and X may be different from each other. A hydrolytic group which is indicated by the X forms a silanol by hydrolysis and reacts to a hydroxyl group of a base layer such as a substrate (glass, silicon) so as to be connected with the substrate by a siloxane bond. On the other hand, the R has a fluoro group such as

(CF_3) on the surface of the R; thus, the surface of the base layer such as a substrate or the like is changed to be an unwettable surface (having a low surface energy).

[0021]

A self organizing film which is made of an organic molecular film and the like is formed on a substrate by placing the material chemical compounds and a substrate described above into the same airtight container and allowing the container to stand for several days at room temperature. Also, a self organizing film which is made of an organic molecular film and the like is formed on a substrate by maintaining an entire airtight container at a temperature of 100 C° for approximately three hours. The above method relates to a method for forming a self organizing film in an atmospheric phase. In contrast, it is possible to form a self organizing film in a liquid phase. For example, it is possible to form a self organizing film on a substrate by dipping the substrate into a liquid solution which contains a chemical compound material, and cleaning and drying the substrate.

Here, it is preferable to perform a preparatory treatment such as radiating ultraviolet light onto a surface of the substrate and cleaning the substrate with a solvent before forming a self organizing film.

[0022]

As another method for a liquid repelling treatment, it is possible to mention a method such that plasma is radiated under a normal pressure or in vacuum. It is possible to select a gas for a plasma treatment from various gases by taking a surface material and the like for the substrate into account. For example, a fluorocarbon gas such as tetrafluoromethane, perfluorohexane, perfluorodecanem or the like can be used for a plasma treatment. In such a case, it is possible to form a polymer fluoride film with a liquid propelling property on a surface of the substrate.

[0023]

It is possible to perform a liquid repelling treatment by applying a film having a desired liquid repelling property such as a polyimide film modified by a 4fluorideethylene on a surface of the substrate. Here, as a substrate, it is acceptable to use a polyimide film as is.

[0024]

Next, a method for performing a liquid repelling treatment is explained.

A liquid repelling property on a surface of the substrate after the above described liquid repelling treatment is higher than a desired liquid repelling property; therefore, the liquid repelling property is reduced by a lyophylic treatment.

For a method for the lyophylic treatment, a method in which ultraviolet light of 170 to 400 nm is radiated thereupon can be mentioned. By doing this, it is possible to reduce the liquid repelling property of the already formed liquid repelling film by means of destroying the film partially, yet uniformly with respect to the whole.

In this case, it is possible to adjust the extent of reduction of the liquid repelling property by adjusting the time period of radiating the ultraviolet light. However, the extent of reduction of the liquid repelling property can also be adjusted by adjusting a combination of the intensity of the ultraviolet light, the wavelength, and the heat (heating) treatment.

[0025]

As another method of the lyophylic treatment, it is possible to mention a plasma treatment in which an oxygen is used for a reaction gas. By doing this, it is possible to reduce the liquid repelling property of the already formed liquid repelling film by means of destroying the film partially, yet uniformly with respect to the whole.

[0026]

As an additional method for the lyophylic treatment, it is possible to mention a method in which a substrate is exposed to an ozone atmosphere. By doing this, it is possible to reduce the liquid repelling property of the already formed liquid repelling film by means of destroying the film partially, yet uniformly with respect to the whole.

In this case, it is possible to adjust an extent of reduction of the liquid repelling property by adjusting the intensity of radiation of the ultraviolet light, the wavelength, the radiating time period, or the like.

[0027]

(Ejection Process Step)

In an ejection process step for forming wiring, a liquid member which contains conductive fine particles (pattern forming component) is ejected. A dispersed liquid, which is obtained by dispersing conductive fine particles into a dispersion medium, is used as a liquid member which contains conductive fine particles. As conductive fine particles used here, fine particles of a conductive polymer or a super-conductive

material are used in addition to metal particles which contain any one of gold, silver, copper, palladium, and nickel.

[0028]

In order to improve dispersibility, it is possible to use conductive fine particles by coating surfaces of the conductive fine particles with an organic matter or the like. As a material to be used for coating the surfaces of the conductive fine particles, it is possible to mention, for example, an organic solvent such as xylene, toluene or the like, and a citric acid or the like.

Also, it is preferable that the diameter of the conductive particle is in a range of 5 nm to 0.1 μm. If the diameter of the conductive particle is greater than 0.1 μm, a nozzle is apt to be clogged; thus, ejection according to the ink jet method would be difficult. Also, if the diameter of the conductive particle is less than 5 nm, the volume ratio of a coating member to the conductive particle becomes too large; thus, the ratio of the organic material in the obtained film becomes too large.

[0029]

It is preferable that a vapor pressure of a dispersion medium which contains conductive fine particles is in a range of 0.001 mmHg to 200 mmHg (approximately in a range of 0.133 Pa to 26,600 Pa) at room temperature. If the vapor pressure is greater than 200 mmHg, the dispersion medium vaporizes rapidly after the ejection; thus, it is difficult to form a superior film.

Also, the vapor pressure of the dispersion medium is preferably in a range of 0.001 mmHg to 50 mmHg (approximately in a range of 0.133 Pa to 6,650 Pa). If the vapor pressure is greater than 50 mmHg, a nozzle is apt to be clogged due to dryness when liquid drops are ejected according to the ink jet method; thus, it is difficult to perform a stable ejection. On the other hand, in the case of a dispersion medium in which the vapor pressure is lower than 0.001 mmHg, it takes time for drying; thus, the dispersion medium is apt to remain in the film. Therefore, it is difficult to realize a superior conductive film after a heat treatment or an optical treatment later.

[0030]

There is no particular limitation for the dispersion medium as long as the dispersion medium can disperse the conductive fine particles described above and does not cause coagulation. Specifically, in addition to water; alcohols such as methanol,

ethanol, propanol, butanol and the like; hydrocarbon compounds such as n-heptane, n-octane, decane, toluene, xylene, cymene, durene, indene, dipentene, tetrahydronaphthalene, decahydronaphthalene, cyclohexylbenzene and the like; or ether compounds such as ethylene glycol dimethyl ether, ethylene glycol diethyl ether, ethylene glycol methyl ethyl ether, diethylene glycol dimethyl ether, diethylene glycol diethyl ether, diethylene glycol methyl ethyl ether, 1,2-dimethoxyethane, bis(2-methoxyethyl) ether, p-dioxane and the like; and polar compounds such as propylene carbonate, γ-butyrolactone, N-methyl-2-pyrrolidone, dimethylformamide, dimethylsulfoxide, cyclohexanone and the like; can be named. Among these, dispersion media of water, alcohols, hydrocarbon compounds, and ether compounds are preferable in that the particles disperse easily, the dispersion liquid is stable, and these dispersion media can be applied easily to the ink jet method. As further preferable dispersion media, it is possible to name water and hydrocarbon compounds. These dispersion media can be used singly or as a mixture of two or more types.

[0031]

When the conductive fine particles described above are dispersed in a dispersion medium, a dispersion mass density is in a range of 1 (one) mass % to 80 (eighty) mass %; thus, it is possible to adjust the dispersion mass density according to a desired thickness of the conductive film. When the dispersion mass density exceeds 80 mass %, coagulation tends to occur and it is difficult to obtain an uniform film.

[0032]

It is preferable that a surface tension of the dispersion liquid for the conductive fine particles described above is in a range of 0.02 N/m to 0.07 N/m. If the surface tension is less than 0.02 N/m when a liquid is ejected according to the ink jet method, a wettability of the ink formation material against the nozzle surface increases; thus, a flying curve tends to occur easily. If the surface tension exceeds 0.07 N/m, a meniscus shape on a tip of the nozzle is not stable; thus, it is difficult to control an ejecting amount and ejecting timing.

[0033]

In order to adjust the surface tension, a small amount of a surface tension adjusting agent such as a fluoride series, a silicon series, a nonionic series or the like can be added into the above described dispersion liquid within the limits of not reducing

the contact angle to the substrate unsuitably. A nonionic surface tension adjusting agent improves a wettablity of the liquid to the substrate and a leveling characteristic of the film, and is useful to prevent roughening on the coated film from occurring. The above described dispersion liquid may contain organic compounds such as alcohol, ether, ester, ketone, and the like if necessary.

[0034]

It is preferable that the viscosity of the above described dispersion liquid is in a range of 1 mPa·s and 50 mPa·s. If the viscosity is less than 1 mPa·s when the dispersion liquid is ejected according to the ink jet method, a periphery of the nozzle is subject to contamination caused by overflowing ink. Also, if the viscosity is greater than 50 mPa·s, the nozzle hole is frequently clogged; thus, it is difficult to eject the liquid drop smoothly.

[0035]

In the present embodiment, a liquid drop of the above described dispersion liquid is ejected from an ink jet head and falls down to a position where wiring is to be formed on the substrate. In this case, in order that a liquid bulge is not formed, it is necessary to control overlap of the liquid drops being continuously ejected. It is also possible to adopt an ejecting method such that a plurality of liquid drops are ejected separately and detached from each other in a first ejection process, and the spaces between the plurality of liquid drops are filled in by liquid drops ejected in a second injection process and injection processes thereafter.

[0036]

After the liquid drops are ejected, a drying treatment is performed in order to remove a dispersion medium according to need. The drying treatment can be performed, for example, by means of a method using an ordinary hot plate, an electrical furnace, or the like for heating a substrate, or a lamp annealing method. A light source for the lamp annealing method is not limited to a particular light source. For example, an infrared lamp, a xenon lamp, a YAG laser, an argon laser, a carbonic acid gas laser, or an excimer laser such as XeF, XeCl, XeBr, KrF, ArF, ArCl, or the like can be used for the light source. Generally, the light sources used are within an output range of 10W to 50W. However, in the present embodiment, it is sufficient that a light source has an output in the range of 100W to 1000W.

[0037]

(Heat Treatment / Optical Treatment Process Step)

It is necessary to remove the dispersion medium completely from a dried film after the ejection process step in order to improve electrical contacts between the fine particles. In addition, when a coating agent such as an organic compound or the like is coated on the surfaces of conductive fine particle in order to improve the dispersibility, it is also necessary to remove this coating agent. Therefore, a heat treatment or an optical treatment is performed or both are performed on the substrate after the ejection process step.

[0038]

Although the heat treatment or the optical treatment is usually performed in open air, it is also possible to perform the heat treatment or the optical treatment in an inert gas atmosphere using nitrogen, argon, helium or the like according to need. A temperature for the heat treatment or the optical treatment is determined suitably according to factors such as a boiling point (vapor pressure) of the dispersion medium, type and pressure of the atmospheric gas, thermal behaviors of the fine particles such as a dispersibility, an oxidization property and the like, whether or not there is a coating agent, an amount of the coating agent, and a heat-resistant temperature of the base material, and the like. For example, it is necessary to sinter the base member at a temperature of approximately 300 °C in order to remove a coating agent comprising an organic material. Also, when a substrate of a plastic or the like is used, it is preferable to sinter the base member in a temperature range of room temperature to 100 °C.

[0039]

The heat treatment or the radiation treatment can be performed by using an ordinary hot plate or an electrical furnace, or by a lamp annealing method. A light source for the lamp annealing method is not limited to a particular light source. For example, an infrared lamp, a xenon lamp, a YAG laser, an argon laser, a carbonic acid gas laser, or an excimer laser such as XeF, XeCl, XeBr, KrF, ArF, ArCl or the like can be used for the light source. Generally, these light sources used are within an output range of 10W to 50W. However, in the present embodiment, it is sufficient that a light source has an output range of 100W to 1000W. By performing the above process steps, after the ejection process step, the dried film is ensured to have electrical contacts

between he fine particles and as a result, the film has been converted to a conductive film.

In this way, by using the conductive film formed according to the present invention, superior and desired conductive film wiring can be formed without generating a defect such as a line breakage or the like.

[0040]

Second Embodiment

As a second embodiment, a wiring forming device, which performs the wiring forming method of the first embodiment described above, will be explained as an example of a film pattern forming device of the present invention.

[0041]

FIG. 1 is a perspective view for showing a general structure of a wiring forming device according to the present embodiment. As shown in FIG. 1, a wiring forming device 100 comprises an ink jet head group 1, an X-direction guide shaft 2 which drives the ink jet head group 1 in the X-direction, and an X-direction driving motor 3 which rotates the X-direction guide shaft 2. The wiring forming device 100 further comprises a mounting base 4 for mounting a substrate W thereon, a Y-direction guide shaft 5 which drives the mounting base 4 in the Y-direction, and a Y-direction driving motor 6 which rotates the Y-direction guide shaft 5. Also, the wiring forming device 100 is provided with a base 7 on which the X-direction guide shaft 2 and the Y-direction guide shaft 5 are fixed on respective prescribed positions thereon. A controlling device 8 is provided beneath the base 7. The wiring forming device 100 is further provided with a cleaning mechanism section 14 and a heater 15.

[0042]

The ink jet head group 1 is provided with a plurality of ink jet heads which places a dispersion liquid including conductive fine particles onto the substrate at a prescribed interval by means of ejecting the dispersion liquid from nozzles (ejection outlets). Additionally, it is possible to eject the dispersion liquid from each of the plurality of ink jet heads independently according to an ejection voltage which is supplied from the controlling device 8. The ink jet head group 1 is fixed on the X-direction guide shaft 2. The X-direction driving motor 3 is connected to the X-direction guide shaft 2. The X-direction driving motor 3 is a stepping motor or the

like and rotates the X-direction guide shaft 2 when a driving pulse signal for the X-axis direction is received from the controlling device 8. Then, when the X-direction guide shaft 2 is rotated, the ink jet head group 1 moves in the X-axis direction with respect to the base 7.

[0043]

The substrate W to which a dispersion liquid is ejected by this wiring forming device 100 is mounted on the base mount 4. The base mount 4 is provided with a mechanism for fixing this substrate W to a reference position. The mounting base 4 is fixed to the Y-direction guide shaft 5. Y-direction driving motors 6, 16 are connected to the Y-direction guide shaft 5. The Y-direction driving motors 6, 16 are stepping motors or the like and rotate the Y-direction guide shaft 5 when a driving pulse signal for the Y-axis direction is received from the controlling device 8. Consequently, when the Y-direction guide shaft 5 is rotated, the base mount 4 moves in the Y-axis direction with respect to the base 7.

[0044]

The cleaning mechanism section 14 is provided with a mechanism which cleans the ink jet head group 1. The cleaning mechanism section 14 moves along the Y-direction guide shaft 5 by the Y-direction driving motor 16. The movement of the cleaning mechanism section 14 is also controlled by the controlling device 8.

[0045]

The heater 15 is a means for performing a heat treatment on the substrate W by a lamp annealing method in this case, and performs the heat treatment in order to make the liquid ejected on the substrate evaporate and dry as well as to convert the liquid into a conductive film. The controlling device 8 also controls the electrical power of the heater 15 for turning it on and off.

[0046]

In the wiring forming device 100 of the present embodiment, in order to eject the dispersion liquid in a prescribed wiring forming area, prescribed diving pulse signals are supplied from the controlling device 8 to the X-direction driving motor 3 and the Y-direction driving motor 6 so that the ink jet head group 1 and the mounting base 4 are moved. Accordingly, the ink jet head group 1 and the substrate W (mounting base 4) are moved with respect to each other. Then, during such a relative movement, an

ejection voltage is supplied to a prescribed ink jet head 30 in the ink jet head group 1 from the controlling device 8 so that the dispersion liquid is ejected from this ink jet head 30.

[0047]

In the wiring forming device 100 of the present embodiment, an ejected amount of a liquid drop from each ink jet head in the ink jet head group 1 can be adjusted according to an ejection voltage supplied from the controlling device 8. Also, a pitch of the ejected liquid drop on the substrate W is determined by a relative movement speed between the ink jet head group 1 and the substrate W (mounting base 4) as well as an ejection frequency (frequency of the supplied ejection voltage) from the ink jet head group 1.

[0048]

According to the wiring forming device 100 of the present embodiment, it is possible to accomplish a narrow wiring line and a thick film without causing a bulge, and it is possible to form a conductive film with a uniform thickness and a suitable edge shape.

Therefore, according to the present embodiment, it is possible to form conductive film wiring, which is advantageous to the electrical conductivity due to having a thick film and which can be formed minutely, and in which it is a difficult for a defect such as a line breakage, a short circuit or the like to occur.

[0049]

Third Embodiment

As a third embodiment, a method for forming a silicon film pattern, which is an example of a film pattern forming method of the present invention, will be explained. A method for forming a silicon film pattern of the present embodiment comprises the process steps for performing a surface treatment process step, an ejection process step, and a heat treatment or an optical treatment process step.

Each process step will be explained bellow.

[0050]

(Surface Treatment Process Step)

As a substrate on which a silicon film pattern is to be formed, various materials such as a Si wafer, a silica glass, a glass, a plastic film, a metal plate and the like can be

used. In addition, the one which has a base layer such as a semiconductor layer, a metal layer, a dielectric layer, an organic layer and the like formed on a substrate with one of the above described various substrate materials can also be used as a substrate on which a silicon film pattern is to be formed.

[0051]

On a surface of this substrate on which the silicon film pattern is to be formed, it is preferable to control a liquid repelling property (wettability) against a liquid containing conductive fine particles. Specifically, it is preferable to set a contact angle of the liquid with respect to a surface of the substrate to be in a range of 15° to 45°. Furthermore, in order to determine a setting value for a contact angle within the range described above, first, a type of a substrate on which conductive film wiring is to be formed and a type of a liquid drop which is employed are determined. Then, a relationship between the contact angle and a diameter of the liquid drop after ejection onto the substrate are determined based on the above condition. Accordingly, the desired contact angle is determined based on the diameter of the liquid drop.

In this manner, a method of a surface treatment for obtaining a desired contact angle is the same as that in the first embodiment; thus, the explanation for this method is omitted.

[0052]

(Ejection Process Step)

When forming a silicon film pattern, a liquid ejected during an ejection process step is a liquid containing an organic silicon compound. As the liquid containing an organic silicon compound, a liquid solution obtained by dissolving an organic silicon compound in a solvent is used. The organic silicon compound which is used in this case is a silane compound which has a ring system which is indicated by a general expression such as Si_nX_m (here, X denotes a hydrogen atom and/or a halogen atom, n denotes an integer of 3 or more, m denotes an integer which is n, 2n - 2, 2n, or 2n + 2).

Here, although the integer n is defined as 3 or more, in terms of thermodynamic stability, solubility, refining easiness, and the like, it is preferable that a ring silane compound has n in a range of 5 to 20, and in particular n of 5 or 6. When n is not at least 5, the silane compound itself becomes unstable because of a distortion due to a ring; thus, it is difficult to handle the silane compound. In addition, when n is

greater than 20, the solubility decreases due to a coagulating ability of the silane compound; thus there will be fewer choices for the solvent.

Also, in a general expression of Si_nX_m which is used in the present invention, X denotes a hydrogen atom and/or a halogen atom. These silane compounds are precursor compounds for a silicon film; therefore, it is necessary to form an amorphous or poly-crystal silicon by the heat treatment or the optical treatment later. During these treatments, silicon-hydrogen bonds and silicon-halogen bonds are split, and newly formed silicon-silicon bonds are created, and are changed to silicon later. A halogen atom is usually a fluoride atom, chlorine atom, bromine atom, or iodine atom. In terms of splitting the bonding described above, chlorine or bromine is preferable. It is acceptable that X is a single hydrogen atom or a single halogen atom. Also, it is acceptable that X is a partially halogenated silane compound so that a total of hydrogen atoms and halogen atoms becomes m.

[0053]

Furthermore, for these silane compounds, a chemical compound, which is denatured by a third family or a fifth family element such as boron, phosphor or the like, can also be used according to need. As a specific example of the denatured silane compound, a silane compound which does not contain a carbon atom is preferable. For such a denatured single compound, a denatured silane compound which is indicated by a general expression of $Si_aX_bY_c$ (here, X denotes a hydrogen atom and/or a halogen atom, Y denotes a boron atom or a phosphor atom, 'a' denotes an integer which is greater than 3, b denotes an integer which is in a range of 'a' to $(2a + c + 2)$, and c denotes an integer which is in a range of 1 to 'a') can be mentioned. in terms of thermodynamic stability, solubility, refining easiness, and the like, it is preferable that a denatured silane compound has $(a + c)$ in a range of 5 to 20, and, in particular, $(a + c)$ of 5 or 6. When $(a + c)$ is not greater than 5, the silane compound itself becomes unstable because of a distortion due to a ring; thus, it is difficult to handle the silane compound. In addition, when $(a + c)$ is greater than 20, the solubility decreases due to a coagulating ability of the silane compound; thus there will be fewer choices for the solvent.

Also, in a general expression of $Si_aX_bY_c$ which is used in the present invention, X denotes a hydrogen atom and/or a halogen atom as similar to a case for the X in a general expression for a non-denatured silane compound which is expressed by Si_nX_m .

The X usually denotes a fluoride atom, chlorine atom, bromine atom, and iodine atom. In terms of splitting the bonding described above, chlorine or bromine is preferable. It is acceptable that X is a single hydrogen atom or a single halogen atom. Also, it is acceptable that X is a partially halogenated silane compound so that a total of the hydrogen atoms and halogen atoms eguals b.

[0054]

It is preferable that a vapor pressure of a dispersion medium which contains an organic silicon compound is in a range of 0.001 mmHg to 200 mmHg (approximately in a range of 0.133 Pa to 26,600 Pa) at room temperature. Because, when the vapor pressure is greater than 200 mmHg, the dispersion medium vaporizes rapidly after the ejection and it is difficult to form a superior film.

In addition, it is preferable that a vapor pressure of the dispersion medium is in a range of 0.001 mmHg to 50 mmHg (approximately in a range of 0.133 Pa to 6,650 Pa). Because, when the vapor pressure is greater than 50 mmHg, a nozzle may be clogged often when liquid drops are ejected according to the ink jet method; thus, it is difficult to perform a stable ejection.

On the other hand, in the case of a dispersion medium in which the vapor pressure is lower than 0.001 mmHg, it takes time for drying; thus, the dispersion medium is apt to remain in the film. Therefore, it is difficult to realize a superior conductive film after a heat treatment or an optical treatment later.

[0055]

There is no limitation on solvents to be used as long as it is possible to dissolve the organic silicon compound described above. In addition to a solvent, which contains a hydrocarbons, such as n-heptane, n-octane, decane, toluene, xylene, cymene, durene, indene, dipentene, tetrahydronaphthalene, decahydronaphthalene, cyclohexylbenzene, or the like, it is possible to name an ether solvent such as ethylene glycol dimethyl ether, ethylene glycol diethyl ether, ethylene glycol methyl ethyl ether, diethylene glycol dimethyl ether, diethylene glycol diethyl ether, diethylene glycol methyl ethyl ether, 1,2-dimethoxyethane, bis(2-ethoxyethyl) ether, p-dioxane, or the like, and a polar solvent such as propylene carbonate, γ-butyrolactone, N-methyl-2-pyrrolidone, dimethylformamide, dimethylsulfoxide, cyclohexanone, or the like.

Among these solvents, in terms of a solubility of the organic silicon compound and a stability of this liquid solution, a hydrocarbon solvent and an ether solvent are preferable. As a further preferable solvent, it is possible to name a hydrocarbon solvent. These solvents can be used independently or as a mixture of two or more types.

[0056]

A solution oncentiation for dissolving the above described organic silicon compound into a solvent is in a range of 1 mass % to 80 mass %. The solution concentration can be adjusted according to a desired thickness of a silicon film. When the solution concentration exceeds 80 mass %, coagulation is apt to occur, thus, it is difficult to realize a uniform film.

[0057]

It is preferable that a surface tension of the liquid solution of the above described organic silicon compound is in a range of 0.02 N/m to 0.07 N/m for the following reasons. That is, when a liquid is ejected according to the ink jet method, when the surface tension is not greater than 0.02 N/m, a wettability of the ink composition with respect to the nozzle surface increases. Accordingly, a flying curve is apt to occur. On the other hand, when the surface tension is greater than 0.07 N/m, a meniscus shape at a tip of the nozzle is not stable. Accordingly, it is difficult to control an ejecting amount and ejecting timing.

[0058]

In order to adjust a surface tension, it is possible to add a small amount of surface tension adjusting agent such as an agent containing a fluoride series, a silicon series, a nonionic series, or the like to the above described liquid solution to the extent that a contact angle to the substrate does not decreases excessively. A surface tension adjusting agent containing a nonionic series improves a wettability of the liquid with respect to the substrate and a leveling characteristics of the film, and prevents roughening from occurring on the film.

It is acceptable that the above described liquid solution contains an organic compound such as alcohol, ether, ester, ketone or the like according to need.

[0059]

It is preferable that a viscosity of the above described liquid solution is in a

range of 1 mPa·s to 50 mPa·s. When ejecting the liquid solution according to the ink jet method, if a viscosity is smaller than 1 mPa·s, a periphery of the nozzle is apt to be contaminated by overflowed ink. In addition, if the viscosity is greater than 50 mPa·s, nozzle hole clogging occurs frequently; thus, it is difficult to eject the liquid drops smoothly.

[0060]

In the present embodiment, a liquid drop of the above described liquid solution is ejected from an ink jet head and drops on a position where wiring is to be formed on the substrate. In this case, in order that a liquid bulge is not formed, it is necessary to control overlap of the liquid drops being continuously ejected. It is also possible to adopt an ejecting method so that a plurality of liquid drops are ejected separately and detached from each other at a first ejection, and the spaces between the plurality of liquid drops are filled in by liquid drops ejected at a second injection and thereafter.

[0061]

After the liquid drop is ejected, a drying treatment is performed in order to remove a solvent according to need. The drying treatment can be performed, for example, by means of a method using an ordinary hot plate, an electrical furnace, or the like for heating a substrate, or a lamp annealing method. A light source for the lamp annealing method is not limited to a particular light source. For example, an infrared lamp, a xenon lamp, a YAG laser, an argon laser, a carbonic acid gas laser, or an excimer laser such as XeF, XeCl, XeBr, KrF, ArF, or ArCl, or the like can be used for the light source. Generally, these light sources used are within an output range of 10W to 50W. However, in the present embodiment, it is sufficient that a light source has an output in the range of 100W to 1000W.

[0062]

(Heat Treatment / Optical Treatment Process Step)

After the ejection process step, it is necessary to remove a solvent from the liquid solution and to convert the organic silicon compound to an amorphous silicon or a poly-crystal silicon. For this purpose, a heat treatment or an optical treatment is performed on the substrate after the ejection process step.

[0063]

The heat treatment or the optical treatment can be performed in an inert gas

atmosphere using nitrogen, argon, helium or the like according to need. A temperature for the heat treatment or the optical treatment is suitably determined by considering factors such as a boiling point (vapor pressure) of the dispersion medium, a type as well as a pressure of the atmospheric gas, thermal behaviors of the fine particles such as dispersibility, an oxidization property and the like, whether or not there is a coating agent, an amount of the coating agent, a heat-resistant temperature of the base material, and the like.

Usually, the heat treatment or the optical treatment is performed in an argon atmosphere, or in argon which contains hydrogen, at a temperature range of 100 °C to 800 °C. Preferably, the heat treatment or the optical treatment is performed at a temperature range of 200 °C to 600 °C. More preferably, the heat treatment or the optical treatment is performed in a temperature range of 300 °C to 500 °C. Usually, when the heat treatment is performed at approximately 550 °C or lower, an amorphous silicon film is obtained. When the heat treatment is performed at a temperature higher than 550 °C, a poly-crystal silicon film is obtained. When the temperature does not reach 300 °C, thermal decomposition of the organic silicon compound does not proceed sufficiently; thus, there is a case in which it is not possible to form a silicon film having sufficient thickness. When a poly-crystal silicon film is desired, it is possible to convert the obtained amorphous silicon film described above into a poly-crystal silicon film by performing a laser-annealing operation. Also, as an atmosphere used during performing the above described annealing operation, it is preferable to use an inert gas such as helium, argon or the like, or gasses obtained by mixing the inert gas with a reducing gas such as hydrogen or the like.

[0064]

The heat treatment or the radiation treatment can be performed, for example, by a method using an ordinary hot plate, an electrical furnace, or the like, or by a lamp annealing method. A light source for the lamp annealing method is not limited to a particular light source. For example, an infrared lamp, a xenon lamp, a YAG laser, an argon laser, a carbonic acid gas laser, or an excimer laser such as XeF, XeCl, XeBr, KrF, ArF, ArCl, or the like can be used for the light source. Generally, these light sources used are within an output range of 10W to 50W. However, in the present embodiment, it is sufficient that a light source has an output in the range of 100W to 1000W.

By performing the above process steps, the liquid solution after the ejection process step is converted to an amorphous silicon film or a poly-crystal silicon film.

In this way, the silicon film pattern formed according to the present invention, enables formation of an excellent and desired pattern without a defect such as wiring breakage or the like.

[0065]

Fourth Embodiment

As a fourth embodiment, a liquid crystal device, which is an example of an electro-optic device according to the present invention, will be explained.

FIG. 2 is a plan view for a layout of signal electrodes and the like on a first substrate in a liquid crystal device according to the present embodiment. As a general structure, the liquid crystal device of the present embodiment comprises a first substrate, a second substrate (not shown in the drawing) on which a scanning electrode and the like are disposed, and a liquid crystal (not shown in the drawing) which is sealed between the first substrate and the second substrate.

[0066]

As shown in FIG. 2, a plurality of signal electrodes 310 are disposed in a multi-matrix state in a pixel region 303 on a first substrate 300. In particular, each signal electrode 310 is provided with a plurality of pixel electrode portions 310a which are disposed so as to correspond to each pixel and a signal wiring portion 310b which connects these pixel electrode portions 310a in a multi-matrix state, and is expanded in the Y direction.

[0067]

Reference numeral 350 is a liquid crystal driving circuit having a one-chip structure. The liquid crystal driving circuit 350 and an end side (a bottom side for a viewer of the drawing) of the signal wiring portion 310b are connected via a first wiring 331. Also, reference numeral 340 denotes a vertical conductive terminal. The vertical conductive terminal 340 and a terminal which is disposed on a second substrate (not shown in the drawing) are connected by a vertical conductive material 341. Also, the vertical conductive terminal 340 and the liquid crystal driving circuit 350 are connected via second wiring 332.

[0068]

In the present embodiment, each of the signal wiring portion 310b, the first wiring 331, and the second wiring 332, is disposed on the above described first substrate 300 and is formed by means of the wiring forming method according to the first embodiment using the wiring forming device according to the second embodiment.

According to the liquid crystal display device according to the present embodiment, it is possible to form a liquid crystal display device, which can be miniaturized and formed with a low-profile, and in which it is difficult for a defect such as a line breakage, a short circuit or the like in each wiring type described above to occur.

[0069]

Fifth Embodiment

As a fifth embodiment, a plasma display device, which is an example of an electro-optic device according to the present invention, will be explained.

FIG. 3 is a disassembled perspective view showing a plasma display device 500 according to the present embodiment.

As a general structure, the plasma display device 500 comprises glass substrates 501 and 502 which are disposed to face each other, and a discharging display section 510 which is formed between the glass substrates 501 and 502.

[0070]

The discharging display section 510 is an aggregation of a plurality of discharging chambers 516. In the plurality of the discharging chambers 516, a group of three discharging chambers 516 such as a red discharging chamber 516(R), a green discharging chamber 516(G), and a blue discharging chamber 516 (B) is disposed so as to form one pixel. Address electrodes 511 are formed on an upper surface of the (glass) substrate 501 described above with a prescribed interval in a stripe state. A dielectric layer 519 is formed so as to cover upper surfaces of the address electrodes 511 and the substrate 501. Furthermore, a partition wall 515 is formed on the dielectric layer 519 between the address electrodes 511and 511 along each address electrode 511.

[0071]

In addition, although it is not shown in the drawing, at each of prescribed positions with a prescribed interval in the longitudinal direction of the partition wall 515, a partition wall 515 is also provided on the dielectric layer 519 in a direction orthogonal

to the address electrodes 511. Basically, a rectangular area is formed by partition walls, which neighbor both of the left and right sides of the address electrode 511 in the width direction, and partition walls, which are extended in the direction orthogonal to the address electrode 511. The discharging chambers 516 are formed corresponding to these rectangular areas. A group of three of these rectangular areas forms one pixel.

In addition, a fluorescent material 517 is disposed inside of the rectangular area which is separated by the partition walls 515. The fluorescent material 517 emits fluorescent light of either red, green, or blue. A red fluorescent material 517(R) is disposed at a bottom of the red discharging chamber 516(R). A green fluorescent material 517(G) is disposed at a bottom of the green discharging chamber 516(G). A blue fluorescent material 517(B) is disposed at a bottom of the blue discharging chamber 516(B).

[0072]

Next, at the glass substrate 502 side described above, transparent display electrodes 512 which are made of an ITO (Indium Tin Oxide) are formed in a striped state with a prescribed interval in a direction orthogonal to the above address electrodes 511, and at the same time, metal bus electrodes 512a are formed in order to compensate for the high resistance of the ITO (Indium Tin Oxide). In addition, a dielectric layer 513 is formed so as to cover the transparent display electrodes 512 and the metal bus electrodes 512a. Furthermore, a protecting layer 514 which is made of MgO or the like is formed. Also, two substrates of the substrate 501 and the glass substrate 502 are attached to each other so that the address electrodes 511 and the transparent display electrodes 512 are disposed so as to be orthogonal to each other. Then, the discharging chamber 516 is formed by removing an air from a space which is surrounded by the substrate 501, the partition walls 515, and a protecting layer 514 being formed at the glass substrate 502 side, and by filling the space with a noble gas before sealing it. Here, the transparent display electrodes 512 formed at the glass substrate 502 side are disposed so that two of the transparent display electrodes 512 are arranged for each discharging chamber 516. The above address electrodes 511 and the transparent display electrodes 512 are connected to an alternating current power supply which is not shown in the drawing. Then, by turning on electricity for each electrode, the fluorescent material 517 at a required position in a discharging display section 510 is

excited to emit light so that a color can be displayed.

[0073]

In the present embodiment, each of the address electrodes 511, the transparent display electrodes 512, and the bus electrodes 512a described above is formed by means of the wiring forming method according to the first embodiment using the wiring forming device according to the second embodiment.

According to the present embodiment, it is possible to form a plasma display device, which can be miniaturized and formed with a low-profile, and in which it is difficult for a defect such as a line breakage, a short circuit or the like in each electrode described above to occur.

[0074]

Sixth Embodiment

As a sixth embodiment, a specific example of an electronic apparatus according to the present invention will be explained.

FIG. 4 (a) is a perspective view showing an example of a mobile phone. In FIG. 4 (a), reference numeral 600 denotes a mobile phone main unit. Reference numeral 601 denotes a liquid crystal display section which is provided with a liquid crystal device according to the fourth embodiment.

FIG. 4 (b) is a perspective view showing an example of a portable information processing device such as a word processor, a personal computer or the like. In FIG. 4 (b), reference numeral 700 denotes an information processing device. Reference numeral 701 denotes an inputting section such as a keyboard. Reference numeral 703 denotes an information processing main unit. Reference numeral 702 denotes a liquid crystal display section which is provided with a liquid crystal device according to the fourth embodiment.

FIG. 4 (c) is a perspective view showing an example of a wrist watch type electronic apparatus. In FIG. 4 (c), reference numeral 800 denotes a watch main unit. Reference numeral 801 denotes a liquid crystal display section which is provided with a liquid crystal display device according to the fourth embodiment.

[0075]

The electronic apparatuses shown in FIGS. 16 (a) to 16 (c) are provided with the liquid crystal devices according to the above embodiment. Therefore, these

electronic apparatuses can be miniaturized and formed with a low-profile, wherein it is difficult a defect such as a line breakage, a short circuit or the like in a variety of wiring to occur.

Furthermore, although the electronic apparatus in the present embodiment is provided with a liquid crystal device, the electronic apparatus can be provided with another electro-optic device such as an organic electro-luminescence display device, a plasma display device or the like.

[0076]

Seventh Embodiment

As a seventh embodiment, an embodiment of a non-contact type card medium according to the present invention will be explained.

As shown in FIG. 5, a non-contact type card medium 400 contains a semiconductor integrated circuit chip 408 and an antenna circuit 412 within an enclosure which comprises a card base member 402 and a card cover 418. At least either one of supplying electrical power or data transmission / reception is performed with an external transmitter/receiver which is not shown in the drawing by means of at least either one of an electromagnetic wave coupling or an electrostatic capacity coupling.

[0077]

In the present embodiment, the antenna circuit 412 described above is formed by means of the wiring forming method according to the first embodiment using the wiring forming device according to the second embodiment.

According to the non-contact type card medium according to the present embodiment, it is possible to form a non-contact type card medium, which can be miniaturized and formed with a low-profile, and in which it is difficult for a defect such as a line breakage, a short circuit or the like in the above described antenna circuit 412 is to occur.

[0078]

Example

After a preparatory treatment was performed on a surface of a glass substrate, a liquid repelling treatment was performed. Then, a lyophilic treatment was performed.

In the preparatory treatment, ultraviolet light was radiated onto the surface of

the substrate, and the surface of the substrate was cleaned by a solvent.

In the liquid repelling treatment, a single molecular film of FAS was formed. Specifically, heptadecafluoro-1,1,2,2tetrahydrodecyltriethoxysilane was used as a compound for forming a self organizing film. Both of this compound and the substrate were placed in an airtight container and were maintained at a temperature of 120 C° for two hours.

In the lyophilic treatment, ultraviolet light having a wavelength of 254 nm was radiated for various periods of time.

As described above, by radiating ultraviolet light for various periods of time, the liquid repelling property of the substrate was examined for a contact angle with respect to a main solvent of toluene. The result is shown in Table 1.

[0079]

Table 1

Irradiation Period (sec.)	Contact Angle (deg.)
0	80
15	60
60	45
80	30
90	20

[0080]

Next, a gold particle dispersion liquid (product name: "Perfect Gold" manufactured by Vacuum Metallurgical Co.), which had been made by dispersing gold particles having a diameter of 10 nm in a toluene, was added with xylene so that the liquid was adjusted to have a solute concentration of 60 mass %, a viscosity of 18 cp, and a surface tension of 35 N/m. The liquid was ejected from an ink jet device, which could carry a plurality of ink jet heads, with a prescribed pitch while performing a drying treatment process step in between. As a result, conductive film wiring was formed.

As an ink jet head, a head, which was used for a commercially available printer (product name "PM900C"), was used. However, since a liquid (ink) drawing section

was made of a plastic, the ink drawing section was modified to a metal part in order that the ink drawing section did not dissolve in an organic solvent. A relative movement speed between the substrate and the ink jet head was maintained constant, and the pitch was changed only by adjusting an ejecting frequency.

The substrate used was a glass substrate with an attached polyimide film which had been treated by 4fluorideethylene.

The liquid was ejected by using only one nozzle with a head driving waveform and a head driving voltage so that a volume of an ejected liquid drop becomes 20 pl. When a liquid drop was ejected under this condition, a diameter of the liquid drop after falling on the substrate become approximately 70 μm.

[0081]

FIG. 6 shows a contact angle against a diameter of the liquid drop after falling on the substrate when the gold particle dispersion liquid described above is used.

In this case, when the contact angle is greater than 45° or smaller than 15°, a line breakage of a formed gold line occurs as shown in FIG. 7 (a). In contrast, when the diameter of the liquid drop is maintained in a range of 50 to 100 μm, that is, the contact angle which corresponds to the range of the diameter of the liquid drop is in a range of 15° and 45° as shown in FIG. 6, a good gold line without any line breakage as shown in FIG. 7 (b) is formed. Based on this result, since a desired liquid drop after falling on the substrate described above is 70 μm, a corresponding contact angle becomes 35°.

Accordingly, since the desired contact angle was 35°, a radiation time period of ultraviolet light was determined to be 80 seconds by referring to Table 1.

[0082]

A liquid drop was ejected onto a substrate in an ejection process step shown in the first embodiment. After that, a drying process step was performed by a drying device for five minutes at 100 °C. Furthermore, a heat treatment was performed to the substrate, on which wiring had been formed, for 30 minutes at 300 °C by using a hot plate; thus, a desired gold line was obtained.

[Brief Description of the Drawings]

[Figure 1]

FIG. 1 is a perspective view for a film pattern forming device according to the second embodiment of the present invention.

[Figure 2]

FIG. 2 is a plan view of a first substrate of a liquid crystal device according to the fourth embodiment of the present invention.

[Figure 3]

FIG. 3 a disassembled perspective view for a plasma display device according to the fifth embodiment of the present invention.

[Figure 4]

FIG. 4 (a) to FIG. 4 (c) are views for showing examples for an electronic apparatus according to the sixth embodiment of the present invention.

[Figure 5]

FIG. 5 is a disassembled perspective view for a non-contact type card medium according to the seventh embodiment of the present invention.

[Figure 6]

FIG. 6 shows a relationship between a contact angle and a diameter of a liquid drop ejected on a substrate.

[Figure 7]

FIG. 7 (a) and FIG. 7 (b) are views for a general structure for formed conductive film wiring.

[Brief Description of the Reference Symbols]

100 : WIRING FORMING DEVICE

400 : NON-CONTACT TYPE CARD MEDIUM

412 : ANTENNA CIRCUIT

[Document Type] Drawing

[Document Type] Abstract

[Abstract]

[Problem to be Solved by the Invention]

To provide a film pattern forming method, a film pattern forming device, conductive film wiring, and the like for restraining an occurrence of a defect such as a line breakage, a short circuit, or the like in a film pattern formed by an ink jet method.

[Means for Solving the Problem]

A contact angle of a liquid with respect to a substrate is set by a surface treatment process step so that a defect in a film pattern does not occur. In particular, the contact angle is set to be in a range of 15° to 45°.

[Elected Drawing] FIG. 6

Corresponding figures

FIG. 1 corresponds to FIG. 1 of the English reference document.

FIG. 2 corresponds to FIG. 12 of the English reference document.

FIG. 3 corresponds to FIG. 15 of the English reference document.

FIG. 4 corresponds to FIG. 16 of the English reference document.

FIG. 5 corresponds to FIG. 17 of the English reference document.

FIG. 6 corresponds to FIG. 18 of the English reference document.

FIG. 7 corresponds to FIG. 19 of the English reference document.

FIG. 2

350 : LIQUID CRYSTAL DRIVING CIRCUIT

FIG. 5

400 : NON-CONTACT TYPE CARD MEDIUM

418 : CARD COVER

408 : SEMICONDUCTOR INTEGRATED CIRCUIT CHIP

412 : ANTENNA CIRCUIT

402 : CARD BASE MEMBER

Translator's notes

1. In FIG. 1 (FIG. 1 of the English reference document)

Reference numeral "11" in the English reference document is to be changed to "W".

Reference numeral "20" in the English reference document is to be changed to "100".

2. In FIG. 6 (FIG. 18 of the English reference document)

Incorrect : "DIAMETER OF EJECTED LIQUID DROP ON BASE BOARD"

Correct : "DIAMETER OF EJECTED LIQUID DROP ON SUBSTRATE"

3. In [Figure 2], "third embodiment" in the Japanese original document should be " fourth embodiment".

4. In [Figure 3], "fourth embodiment" in the Japanese original document should be " fifth embodiment".

5. In [Figure 4], "fifth embodiment" in the Japanese original document should be " sixth embodiment".

6. In [Figure 5], "sixth embodiment" in the Japanese original document should be " seventh embodiment".

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Information on Applicant

Identification Number	(000002369)
1. Renewal Date	August 20, 1990
(Reason)	New Registration
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FIG. 1

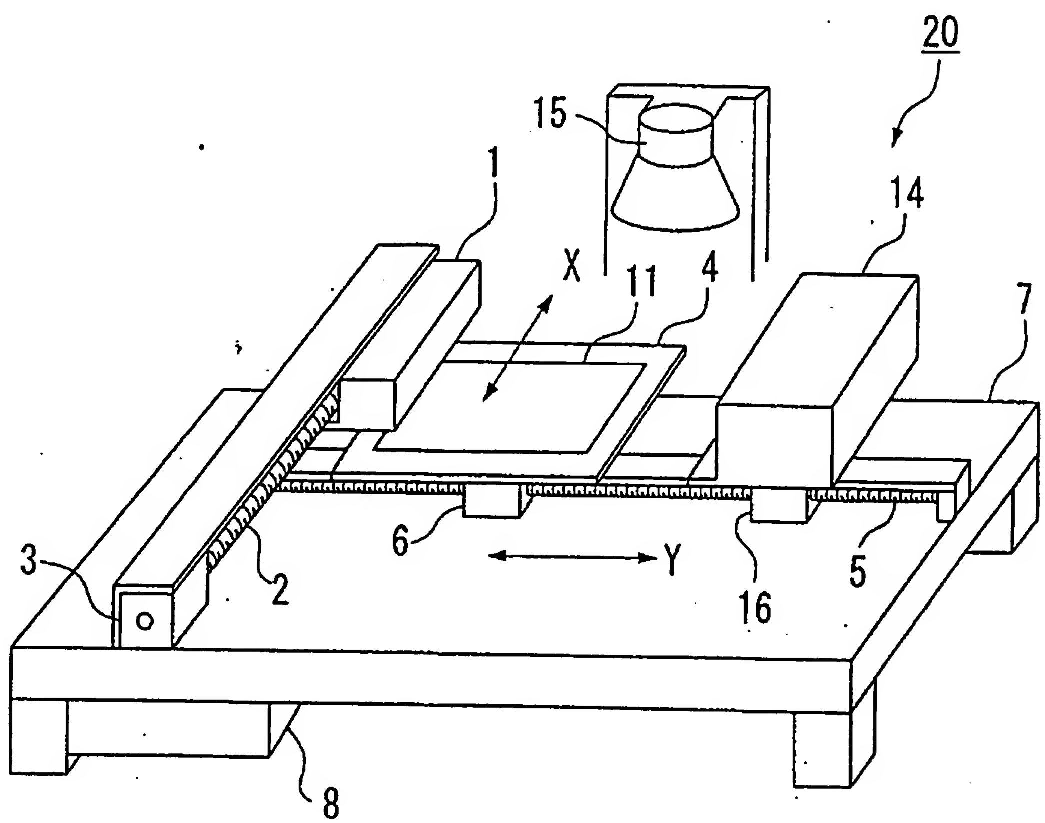


FIG. 2

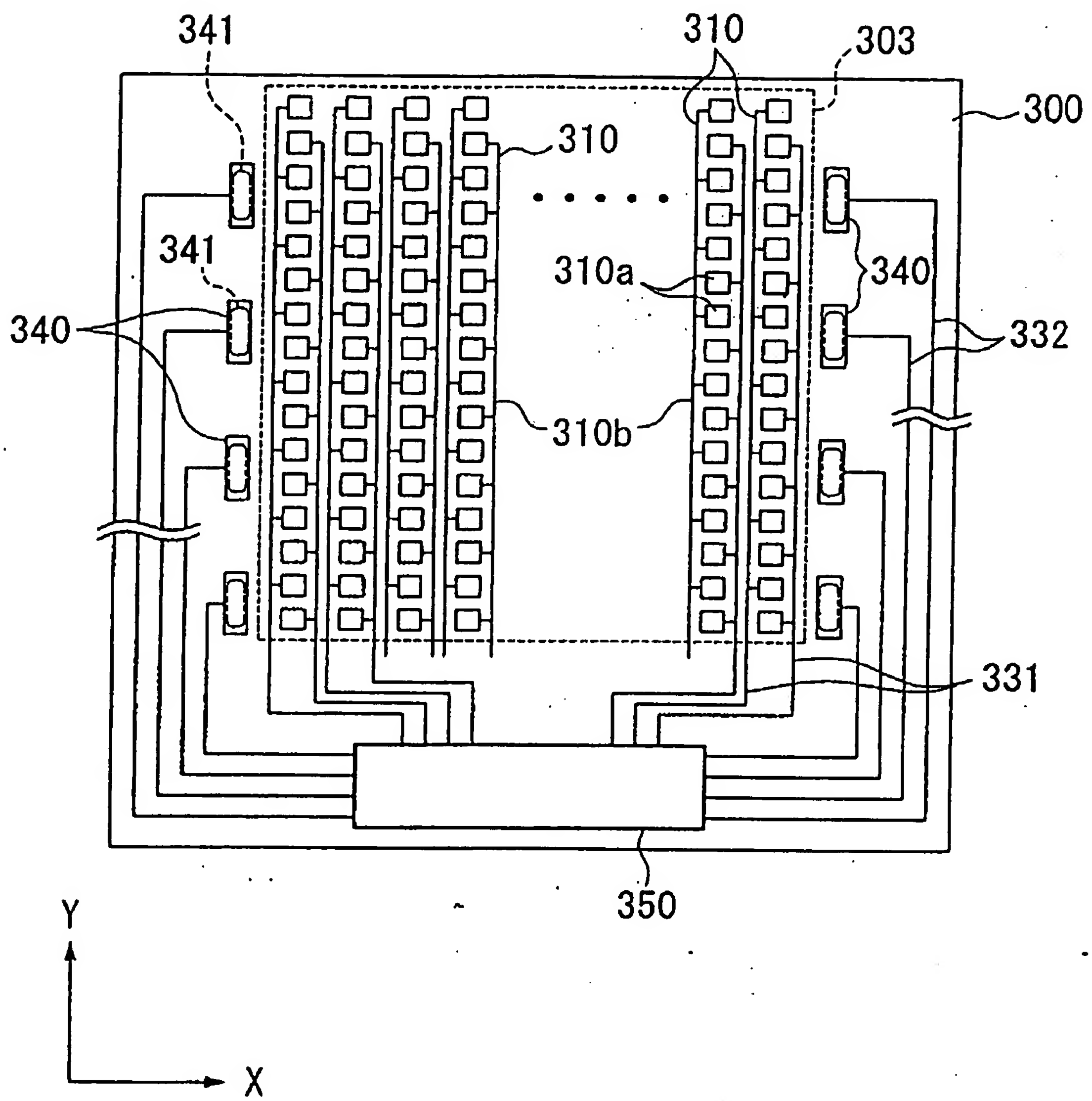
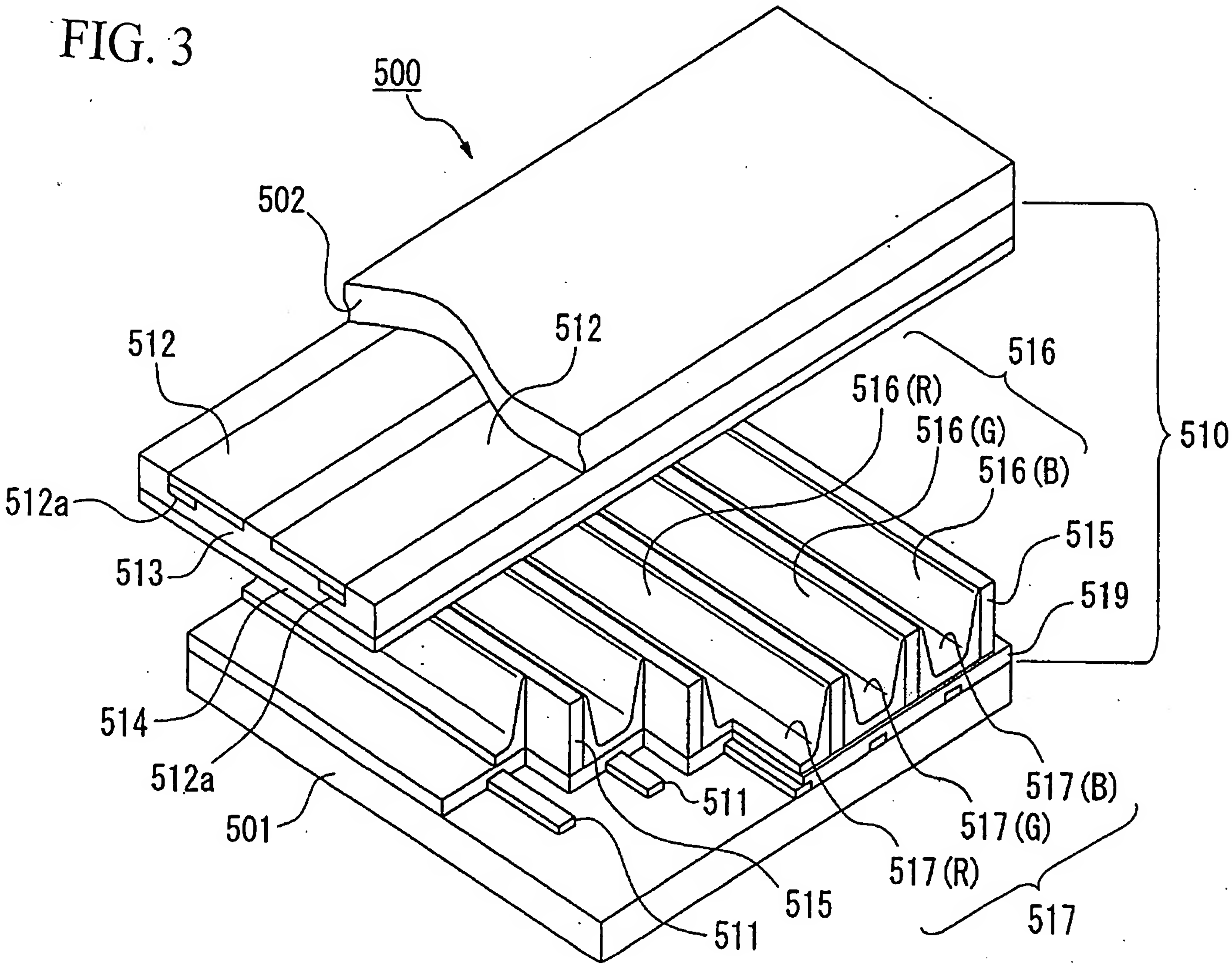


FIG. 3



500
502
512
512
516
516 (R)
516 (G)
516 (B)
510
512a
513
515
519
514
512a
511
501
517 (B)
517 (G)
517 (R)
515
511
517

FIG. 4 (a)

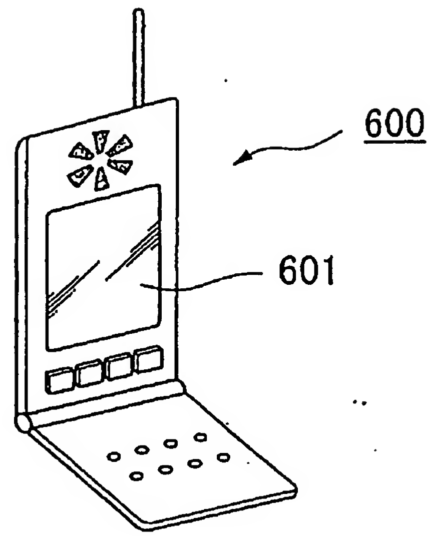


FIG. 4 (b)

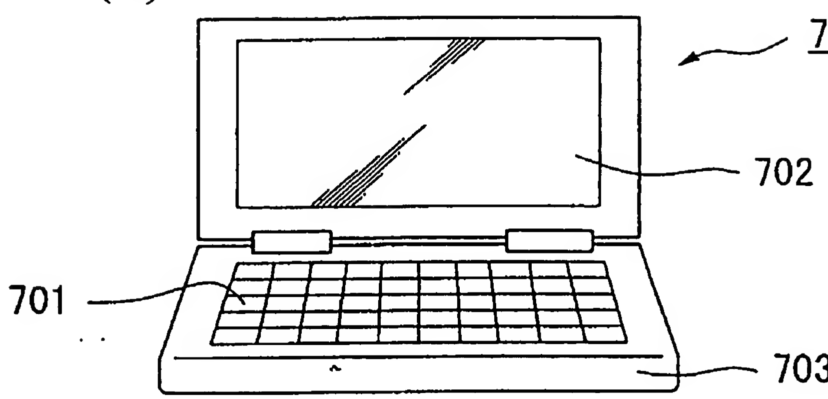


FIG. 4 (c)

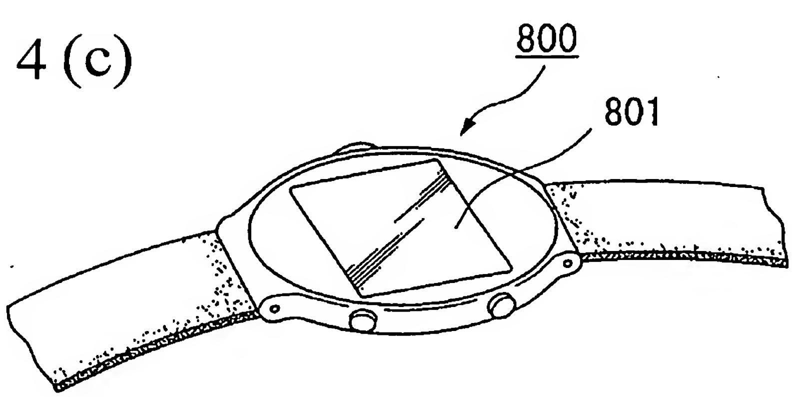


FIG. 5

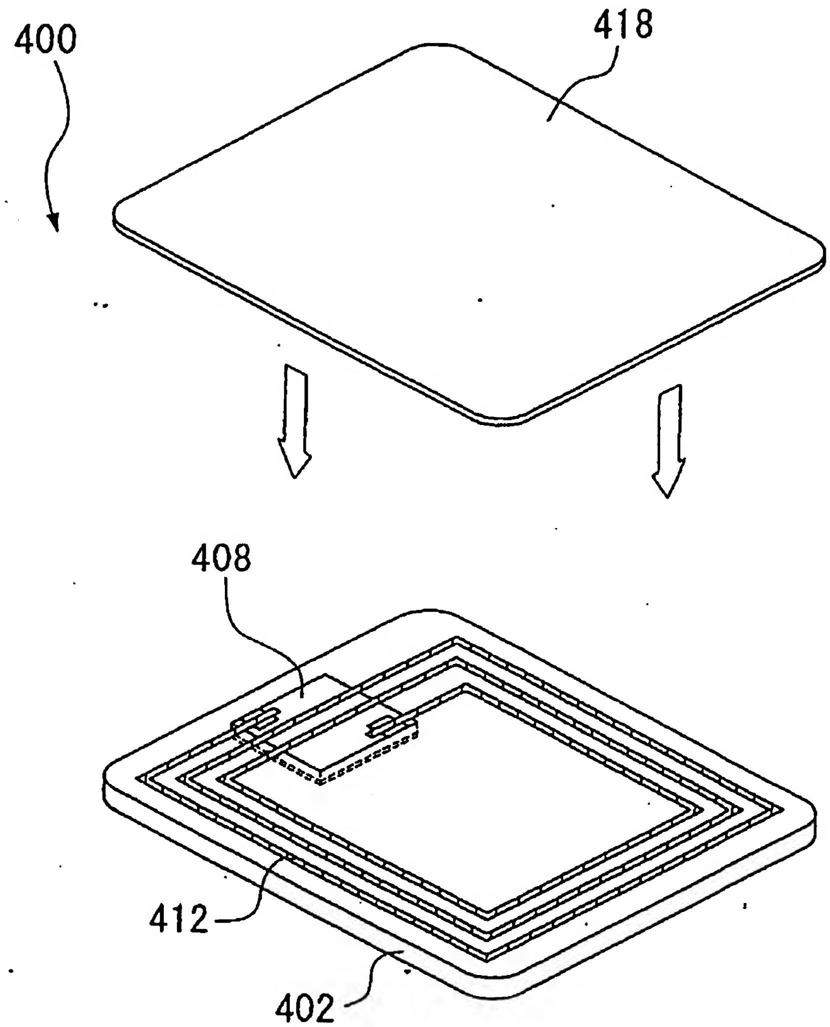


FIG. 6

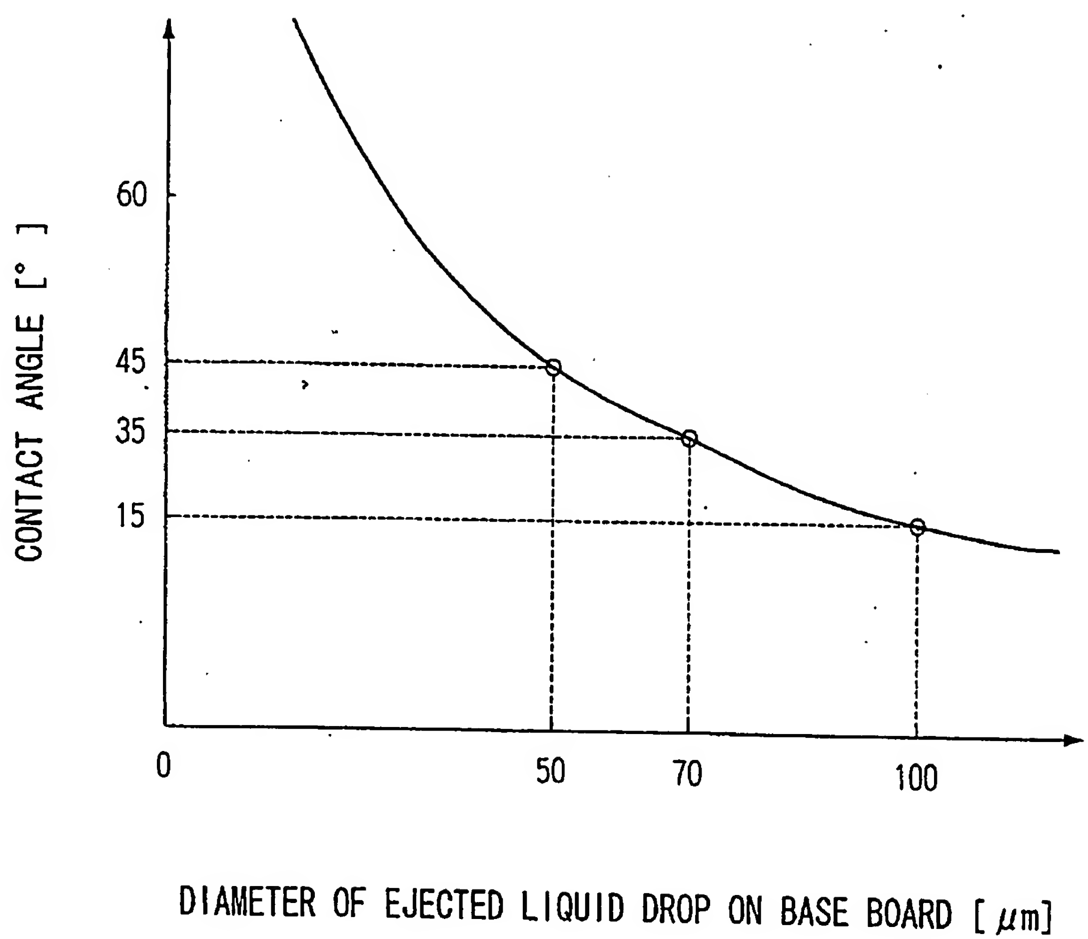

CONTACT ANGLE [°]
60
45
35
15
0
50
70
100
DIAMETER OF EJECTED LIQUID DROP ON BASE BOARD [μm]

FIG. 7 (a)

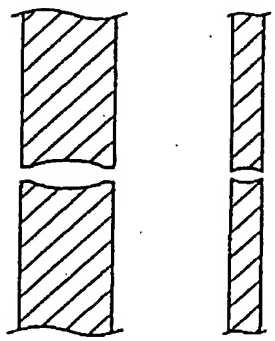


FIG. 7 (b)